cursor on the display **102**, the microprocessor **112** directs a power driver **118** to drive the user manipulable device **10** to produce force feedback. The power driver **118** may, for instance, control the electromagnet **30** to generate the desired magnetic field to move the magnet and inertial member in the device **10**. In one example, the electromagnet **42** of the device **10** as directed by the driver **117** generates a magnetic field varying in intensity and frequency in response to inputs from the host computer **100** and in synchronization with the graphical user interface. The force feedback produced in the user manipulable device **10** may effect tactile screen boundaries, as well as virtual walls which correspond to button bar functions or icon placement on a drag-down menu, by increasing and decreasing the vibration or impact force sensed by the user's hand on the interface device **10**.

[**0027**] **FIG. 6** shows yet another embodiment of the tactile FFB mechanism. A permanent magnet **40** is movably disposed in a hollow core of an electromagnet **42** fixed to the device. The electromagnet **42** generates a magnetic field varying in intensity and frequency in response to inputs from a host computer and in synchronization with the graphical interface. The electromagnet **42** typically includes a coil surrounding the magnet **40**. When the coil is energized, the magnet moves up or down depending on the polarity of the field generated by the coil. The magnetic field causes the magnet **40** to slide up and down in the hollow core. The ends **46***a*, **46***b* of the sliding magnet **40** may impact the upper case portion **48***a*, the lower case portion **48***b*, or both, to produce different tactile forces, or the sliding magnet **40** may only vibrate between the case portions **48***a*, **48***b* without making contact so as to produce pure vibration. The ends **46***a*, **46***b* may include an elastomeric material. Alternatively or additionally, the case portions **48***a*, **48***b* may include an elastomeric material. Springs **49***a*, **49***b* are desirably provided to support and space the moving magnet **40** between the case portions **48***a*, **48***b* in a neutral position. The electromagnetic forces generated by the electromagnet **42** overcomes the spring forces to drive the moving magnet **40** up and down. The mechanism of **FIG. 6** may be more compact than the mechanism of FIGS. **1-5**.

[**0028**] In an alternative embodiment shown in **FIG. 7, a** shaft **50** extends from the moving magnet **52** driven by the electromagnet **54** to move up and down. The contact member **56** is connected to the end of the shaft **50** to move between a top surface **58** and a bottom surface **60**. The shaft **50** and the moving magnet **52** form the inertial member, while the electromagnet **54** is fixed to the device.

[**0029**] In **FIG. 8, a** nonmagnetic metal slug **70** is used instead of a permanent magnet. The metal slug **70** is spring loaded away from the face of the electromagnet **72** by a spring **74**. The spring **74** biases the inertial arm **76** and the contact member **78** at the free end thereof toward the upper case surface **80**. The electromagnet **72** only has to attract the metal slug **70** to move it toward the lower case surface **82**. When the attractive force on the metal slug **70** is removed, the biasing force of the spring **74** returns the metal slug **70** to a position toward the upper case surface **80**. The position of the metal slug **70**, the spring constant of the spring **74**, and the intensity and frequency of the electromagnet **72** can be selected to cause the contact member **78** to strike the upper case surface **80**, the lower case surface **82**, or both, or to vibrate without impact. The device of **FIG. 8** is simpler and typically less expensive to produce.

[**0030**] The above-described arrangements of apparatus and methods are merely illustrative of applications of the principles of this invention and many other embodiments and modifications may be made without departing from the spirit and scope of the invention as defined in the claims. As illustrated by the above examples, there are different ways of configuring and modifying the tactile FFB mechanism according to the present invention. In yet another example as shown in **FIG. 9**, an electromagnet **90** has a C-shaped core **92** movable by the magnetic field generated by a coil **94**. The permanent magnet **96** coupled to the arm **98** is disposed between the ends of the C-shaped core **92** and moves with the core **92** up and down when the coil **94** is energized. The C-shaped core **92** uses the magnetic energy efficiently to move the magnet **96**. The coil **94** can be disposed at different locations relative to the core **92**. This may simplify the design and allows for variation in size and shape of the mechanism. The scope of the invention should, therefore, be determined not with reference to the above description, but instead should be determined with reference to the appended claims along with their full scope of equivalents.

What is claimed is:

**1**. A tactile force feedback apparatus for an input device, the apparatus comprising:

an inertial member having a movable portion being movable relative to the input device;

a magnetically actuatable member connected to the movable portion of the inertial member; and

a magnetic driver configured to generate a magnetic field to move the magnetically actuatable member and the movable portion of the inertial member with respect to the input device to generate tactile force feedback in response to a user's manipulation of the input device.

**2**. The apparatus of claim 1 wherein the magnetically actuatable member is selected from the group consisting of a permanent magnet and a metallic member.

**3**. The apparatus of claim 1 wherein the magnetic drive comprises an electromagnet fixed to the input device.

**4**. The apparatus of claim 1 wherein the magnetically actuatable member is connected to the movable portion of the inertial member to be movable by the magnetic driver in a generally linear manner.

**5**. The apparatus of claim 1 wherein the inertial member comprises an attachment portion attached to the input device.

**6**. The apparatus of claim 5 wherein the inertial member comprises a longitudinal body having an end attached to the input device as the attachment portion and having a free end as the movable portion.

**7**. The apparatus of claim 1 wherein the movable portion of the inertial member comprises a contact member movable to strike the input device.

**8**. The apparatus of claim 7 wherein the contact member of the inertial member is movable between two surfaces of the input device to strike at least one of the two surfaces.

**9**. The apparatus of claim 1 wherein the magnetic driver is configured to generate a magnetic field in synchronization with a graphical user interface.

**10**. The apparatus of claim 1 wherein the contact member comprises an elastomeric material.